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THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

A Purchasing Agent's Guide to Buying Paints and Coatings

U. S. DEPARTMENT OF THE NAVY
CARDEROCK DIVISION, NAVAL SURFACE WARFARE CENTER

in cooperation with
Peterson Builders, Inc.

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A Purchasing Agent's Guide to Buying Paints and Coatings

National Shipbuilding Research Program
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EXECUTIVE SUMMARY

The process of procuring paints and coatings can represent one of the more challenging tasks presented to shipyard purchasing personnel. Standard purchasing principles apply to the procurement of paints and coatings, however, the unique nature of coatings as a commodity, the ever-changing environmental impact issues, and the wide-ranging impact on various groups within the shipyard all play significant roles in the determination of the best coating value for the shipyard.

Evaluating proposed coatings on an equal basis is essential to coating selection process. Included in this effort is the need to compare cost on a cost per square foot basis (instead of cost per gallon), to incorporate the ancillary costs (in terms of additional material, equipment and labor) associated with the use of coatings into the evaluation, and to consider the impact and cost of environmental regulations during use and disposal of the coatings.

The purchasing agent must utilize the input and expertise of a wide and varied cross-sectton of shipyard departments in determinig the best coating value. This necessity places the purchasing group in the unique position of developing a cross-functional communications network that can not only support the purchasing function, but can also improve the overall productivity and efficiency of the shipbuilding process.

This guide provides an overview of coatings as a commodity, the various shipyard groups and departments that can be impacted by the coatings selection PROCESS. the ancillary considerations that are part of the equation, and the melding of these to arrive at the best coating value. 'I'he changes in marine coatings which have been dictated by safety and environmental constraints have placed greater emphasis on making coating choices that will not only provide ship owners with the level of performance they expect, but also provide compliance with current environmental regulations regarding VOCs and waste disposal, and protect the safety and health of shipyard workers. Now, more than ever, selecting the proper coatings is essential to the present and future of American shipyards. 'l'his guide is intended to increase the shipyard purchasing personnel's understanding of coatings and assist them in making prudent and proper value judgments as part of the effort to improve shipyard productivity and quality.

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INTRODUCTION

Shipyards have, for years, been faced with the task of applying paints and coatings to ships under construction and repair. The protection afforded by these materials is critical to the life and operation of any ship. While eliminating corrosion represents the most important function of coatings, they also serve to:

- protect fuel and cargoes from contamination
- maintain potable water in suitable condition
- prevent fouling from accumulating on the hull
- enhance the cosmetic appearance of the ship

Just as these functions provided by coatings on a ship in service are critical to the operation of the ship, the coating process is also an important part of any shipbuilding and repair operation.

Surface preparation and coating application are labor-intenstve and disruptive processes that can have a significant Impact on shipyard production. Much of this effort, typically, comes at the end of the production cycle. so there is frequently a high degree of presure to get the coatings applied and the ship delivered in a short time-span. This is further complicated by the fact that the accumulated schedule slippages of other shipyard departments often come to bear on the paint shop. As such, the paint department is frequently on the hot seat in terms of visibility and pressure to get the job done. They are also a good barometer of the overall effectiveness of a shipyards' productivity. It is an area in which costs are difficult to project and, often, one in which actual costs exceed projected costs for material and labor.

The task of preparing the surface to receive coatings, the selection of coatings for a given area and the successful application of those coatings are functions which can be subjective in nature and a source of controversy. Though governed by established standards and practices, there is still a great deal of gray area for interpretation by those doing the surface preparation and coating and those performing inspection of this work. Accordingly, this can be a source of disagreement which can lead to additional cost (in labor and materials) or reduced quality depending upon how these standards and practices are interpreted.

There are many different coating types on the market, each making claims of suitability for various types of service. While most of the claims are accurate, improper surface preparation and/or coating application can render the highest quality coatings useless for their intended purpose. Thus, it can be difficult to get an accurate perception of the quality of a given coating or coating system. The fact that the coating process (i.e. surface preparation and coating application) is an extremely labor-intensive operation makes it an attractive area for taking shortcuts, further adding to the difficulty of evaluating the quality of a given coating.

The coating process has a great impact on many different shipyard departments and groups. On the production end, surface preparation and coating application is often isolated from other shipyard operations. Work by other trades will be limited while surface preparation and/or coating application is being performed. This is due to the personal and workplace safety concerns which arise from abrasive blasting and the solvent content (and fire and explosion potential) of coatings, as well as the generally dirty and messy nature of both functions.

From a planning and scheduling perspective, accurate man-hour and time estimates to accomplish surface preparation and coating application for a given space are difficult to project. Much depends upon the condition of an area when turned over to the paint shop, accurate square footage estimates, access to the proper equipment to accomplish the job at hand, the inspectors approving the work and, being labor-intensive, the work ethic of those performing the work. Added to this is the fact that the surface preparation and coating application process usually requires exclusive access to an area.

Weather restrictions placed on the coating process add to the difficulty in planning and scheduling. An area may be turned over to the paint department but, due to poor weather, they may not

be able to work that area. This disrupts schedules and dictates adjustments to the overall plan. The potential impact of weather necessitates that constant temperature and dew point readings be taken. This function is often performed by the laboratory, another group involved in the coating operation.

For management the paint department, being at the end of the production cycle, seems perpetually behind schedule and threatening major scheduling milestones such as launch, undocking or delivery. While this is often the result of the accumulated schedule slippages of the departments which preceded the paint shop, the brunt of the pressure is on those still in the space or area.

For the safety group, the coating process is a constant area of concern due to the inherently hazardous nature of both surface preparation and coating application and the fact that access is required into tight and often restrictive areas of the ship.

Finally, the purchasing department must support the paint department by having the proper coatings fn house at the proper time with the proper documentation to allow the paint department to accomplish their job. This effort on the part of the purchasing group to support the surface preparation and coating operation can, and perhaps should, represent one of their mere challenging procurements. Among the factors which purchasing must consider are:

- that without substantial historical data, pro jections of required quantities (as with man-hours) are often inaccurate
- that a wide variety of coating types are **required**
- the hazardous nature of coatings
- the parameters placed upon handling and storage
- the need to support production in the face of constantly changing requirements and schedules, which may result in short or nonexistent lead times
- the need to dispose of wastes generated during the coating process
- the auxiliary purchases of solvents for cleaning and thinning

The nature of coatings and their impact on the shipyard can Increase the complexity of the procurement for the purchasing department. There are often many coating types which can accomplish a given function, so it is difficult to make an equal comparison Of proposed systems. This is complicated by the fact that there is not an easily quantifiable unit *of measure* for coatings. While procure—ments are usually made in gallons, not all gallons are created equal. Even among coatings of the same generic type, a gallon of coating will not always provide an equal amount of coverage as an alternate coating, and systems do not always require the same number of coats or thicknesses of coating.

This *guide* addresses the issues facing purchasing in dealing with the challenging commodity of paints and coatings in a shipyard environment.

THE PURCHASING FUNCTION

Throughout all businesses, there is a common requirement for cost-effective materials, equipment, and services to meet the operational needs of the company. Shipyards are no different-they want the right materials, at the right place. at the right time, and at the very best value possible.

Most organizations employ a purchasing department to execute this function and the general approach is consistent worldwide. Over the years, the role of purchasing has evolved from a fairly simple "three bids and pick the lowest" philosophy to a multi-faceted mission that assesses value with the help of many departments and individuals to arrive at a joint buying decision.

As the purchasing function has grown in complexity, the overriding focus has become value. Each purchasing buy becomes a definition in value which ranges, In its simplest form, from the lowest price all the way to a complex equation involving fifteen or twenty variables. Of paramount importance is to appropriately define value for the shipyard so that the best buying decision can be made.

The purchasing department also has responsibilities that support the actual buying process. Among these are:

- managing the vendor base for their company
- sourcing potential vendors with the ability to meet the requirements of the purchasing department and the specifications of the overall contract
- contingency planning against supply interruption or industry trends
- **building vendor relationships based on trust and mutual benefit**
- motivating vendors to concentrate on creative ways they can add value to their customer's business

One example of a mission statement for a modem purchasing department is:

Promote the cornpany's overall best interests by providing quality, consultative purchasing services that are aligned with the needs of internal and external customers. Purchasing of goods and services will be timely, professional, and creatively use vendor resources such that costs are minimlzed and value is maximized.

Purchasing Function

THE FACTORS WHICH DEFINE VALUE

The evolution of the purchasing process has resulted in a range of indicators about value that is too long to list in its entirely. The folIowing briefly describes some of the more common factors

. PRICE-the most frequently used yardstick as well as the universal language of purchasing and vendors. It usually has the advantage of being easily quantified. The interpretation of pricing can be a challenge when different units of measure are used, or the effect of application/use has a bearing on the amount of product required. The price fader can include clauses that clearly define price adjustments based on raw material cost fluctuations. purchase volume, time-span, changes in indices, etc.

. DELIVERY-the right time at the right place. At times, fast delivery for a crucial production need can outweigh all other factors combined. Avendor's ability to respond with a quick turnaround on an order can make or break their reputation in the business. Meeting delivery commitments on a consistent basis is expected of all quality vendors.

. QUALITY-this measure is hemming much more challenging to define and is frequently composed of a number of factors. Traditional specifications are important, but softer issues have and will continue to emerge. Ultimately, quality is defined by the customer, perhaps through the development of standards, and can vary from buy to buy.

.**VENDOR SUPPORT SERVICES-this** covers a wide range of assistance that vendors can provide as a part of a materials purchase: engineering, technical, training, environmental, application, design, etc. Frequently one or two of these services are critical to the success of a buy and will be addressed separately. Sometimes it is not clear to purchasing how much of the service cost is bundled in the pricing and whether it is “free” or priced with the product. This can be addressed by defining requirements up-front or having support services quoted separately.

. **WAREHOUSING/INVENTORY MANAGEMENT-how** a vendor stores and distributes product can a have a strong impact on their performance. A vendor may establish a ware house near important customers and provide same day delivery service. Others provide on-line order entry services and inventory reports as requested. This kind of service is in a high-growth mode in many industries and allows customers to focus on their core business. Compensation for this service is usually negotiated as a part of the buy.

. **ENVIRONMENT**—a relatively recent addition to the list, but a growing concern at all levels. Waste disposal should be a part of thls factor. Environmental issues can, at times, become the number one factor in a buying decision. Many more regulations/ requirements are being established at all levels: federal, state, and local. Clarity of responsibility is important here since some laws now permit potential claimants to work back up the supply chain as far as possible.

• **SAFETY-a part** of storage, use, and disposal. Impact on employees using the product is the traditional focus of OSHA, vendors, and management.

Ž **VENDOR FINANCIAL** STABILITY--is the selected vendor financially capable of servicing your present and future needs, enhancing their product, innovating? Many purchasing departments request credit reports or financial statements prior to doing business with new vendors. and periodically with existing vendors. The finance department can help interpret the data if it is unclear.

Ž **VENDOR PERSONNEL--do** you consistently deal with the same people or high quality persormel? Is the management team strong? Some companies tend to have high turnover in Sales and support people and the learning curve each time a new person comes on board can be expensive. The ability to meet and have a relationship with the upper management group will serve you well when a problem develops or if extraordimary service is required.

•**GUARANTEE/WARRANTY-**vendor's commitment to the merchantability/fitness for use of the product and adherence to the contract requirements. The Uniform Commercial Code addresses this area, and many vendors specifically exclude certain aspects of warranty in the fine prlnt--readit carefully. First-class vendors will have practical, easy to understand guarantees specific to the parties involved. Occcasionally, vendors will support claims for good customers that are beyond the terms of the original Warranty.

Ž **LEGAL/REGULATORY-some** vendors are clearly on the ball in this area both in knowledge and documentation. However, many don’t have a good grasp of their responsibilities, some of which can end up back with the buying company.

• **PROCESS SAVINGS-often** times, a vendor can suggest creattve ways to use their product that save materials or labor. Depending on how applicable these suggesstions are, they can be factored into the matrix and push a purchase to the creative vendor.

• **PAYMENT TERMS-this** item IS FREQUENTLY overlooked, but can result in good savings depending on the company financial position. If a vendor will accept a discount far prompt payment of 1-3%, significant savings are possible, particularly with interest rates in the single digits. The finance department can explain when it is favorable to negotiate discount terms or possibly extended terms. This item can be negotiated with the selected vendor (and it is definitely negotiable) or can be specified in the RFQ.

Ž ***SOCIAL/COMMUNITY***-thevendor's reputa*tion* and activities in the "community" can sometimes have an impact on the purchasing process. For example, a vendor that has poor environmental practices at their plant may have the lower cost

product as a result, but you may not want to do business with them anyway.

- INTUITIVE APPRAISAL-occasionally. there may be gut feelings by members of the team which should be discussed.

ASSESSING VALUE

It is easy to talk about assessing value, getting input, and making a good purchasing decision. It is another matter to do it consistently and well. Many different skills, company cultural values, relationships, and politics come into play. Nonetheless, the truly successful purchasing agent will rise above the fray and coordinate a purchasing process that reflects a broad base of input resulting in the best value purchase for their company.

TOTAL QUALITY PURCHASING MANAGEMENT

At the heart of a good purchasing program is an environment that supports and encourages cross-functional communication. Healthy and vigorous discussion among all departments impacted by a buying decision is the key to assessing value (and making the best purchasing decision).

Clearly, there is a prioritization effort required to define how much work you can put into a given procurement. Generally, the buys with the greatest potential for impact (material or process-Wise) warrrant the greatest effort. Once the parameters have been set. then the quest for value can begin.

Appendix B-further explains the concepts of Total Quality Management as it applies to the purchasing function and to the operation of companies as a whole.

TEAMWORK

While purchasing is the final buying authority in most organizations, a great deal of interaction and communication takes place prior to the buy. Though purchasing may coordinate much of this, it is important for the primary customer or user of the material to be intimately involved in the value assessment function, as they are in the best position to develop value factors, and coordinate the prioritization/weight of the factors. And, needless to say, they will be the one's using it.

Ideally, the factors on a given buy will be identified and weighted prior to the solicitation of quotes. This allows the RFQ to be written In a way that provides equal baseline information to all potential vendors and to specifically request the needed information in a format that facilitates an apples to apples comparison and/or simplifies the task of evaluating each quote.

The communication and subsequent agreement on the value factors and their weight can come as part of formal team meetings or as a result of individual discussions with the purchasing agent. Frequently it makes sense for the purchasing agent to instigate this communication and continue it through the evaluation process. Once all the lively discussion about the factors and issues has occurred and agreement has been reached, it can be fairly easy to make a decision and proceed with the purchase.

THE EVALUATION MATRIX

One of the most effective tools to assist the purchasing team in the execution of their task is the evaluation matrix This simple, but powerful, tool is a spreadsheet that lists all the value factors down the left (with a weight for each indicating its impoirtance) and the vendors across the top. The purchasing team then reviews each vendor's quotation and past performance to assign a rating, usually from 1-6, indicating their evaluation of each vendor's performance on all the factors. The weight is then multiplied by each rating and a total score for each vendor is calculated at the bottom of the spreadsheet.

The range of scores provides concise way of summarizing each vendor's quote. Most teams will use these scores as a guide for the final decision. Frequently, the scores maybe quite close, allowing other less definable factors to be considered if desired. When one vendor clearly has outperformed the others, the decision may be relatively easy. While these scores can be an effectove tool to aid in the

decision process. they are only a way to simplify what can be a complex evaluation.

Examples of possible evaluation matrices are attached as **Appendix A**

THE LEARNING CURVE

The kind of cross-functional process described may seem complex or require too much time in the fast-paced life of today's' business world where quick results are often critical. Indeed the first time a team approach is used in a significant procurement, it may take some time to work through the definition of roles and responsibilities. Everyone is trying to figure out their part and the facilitator (either the primary user or the purchasing agent) must carefully organize the process and communications such that the team is as effective as possible. This includes distributing information, conducting periodic meetings and ensuring that everyone stays on track to the end, It also requires a commitment from all members of the team throughout the process.

Even though nghit maybe a learning process for everyone the first time, the results are usually very positive-all key players have had an opportunity to have Input into an important part of their work world. There is usually a strong buy-in after the purchase is made and frequently the production process goes more smoothly based on the knowledge gained during the team procurement process. The bulk of the work occurs up front to address potential problems or issues so that when production begins, significant labor costs are not wasted while problems are being resolved.

The major payoff comes when future team purchases are needed. Many of the same people may reinvolved and they are now familiar with their roles and the communications required in the process. As a result, the efficiency of the group is much greater, and the time required can be cut in half or better. Hopefully they have seen the power of this approach and will be all the more ready to actively participate and ensure success.

SUMMARY

Coordinating the cross-functional communication among a large and diverse group of people is a sizable task Some efforts will be more successful than others. But the need to persevere and improve the value of the company's procurement dollars rests squarely with the purchasing department and, by extension, the purchasing team. A home run will be hit on some projects: all the impacted departments will be pleased with the materials and the value to the company will be tremendous. These early successes will establish the necessay communications network and prove the validity of the system. This will make future procurements easier to accomplish and additional successes will follow.

THE COMMODITY

Steel is the primary building material used in the construction of ships. As an extremely strong yet comparatively flexible material, steel is ideally suited for this purpose. However, steel does have one major drawback the propensity to oxidize, or rust. This is especially true in the severe marine environments in which ships usually operate. Coatings and coating systems are used to prevent the deterioration of substrates by modifying or interrupting the electrical process which results in corrosion. Perhaps the most common means of accomplishing this is to apply a barrier to the steel which prevents the electrolyte (any liquid capable of carrying electrical current - usually water or salt water) and oxygen from coming into contact with the steel substrate. As long as this barrier remains intact and prevents the electrolyte (one of the "elements" required for corrosion to occur) and oxygen (which acts as an accelerator for the corrosion process) from coming into contact with the steel, corrosion will not occur. Most coatings used in marine applications operate as some form of barrier to protect steel substrates. Sometimes these coatings will also incorporate anticorrosive pigments into the formulation to augment the barrier protection.

Another means of preventing corrosion is to intentionally sacrifice one material to protect the steel substrate. Metals such as zinc and aluminum will sacrifice preferentially to steel in most electrolytes. This means that when both materials are present together, the sacrificial mataial (i.e. the zinc or aluminum) will sacrifice (or corrode) before the steel will begin to corrode. This is the concept behind sacrificial anodes and the principle upon which galvanizing operates Sacrificial coatings will provide protection to steel substrates as long as there is still sacrificial material on the steel. Therefore, the life span of a sacrificial coating is dependent upon the amount of material applied and the environment in which it is placed. Some systems or coatings, such as inorganic zinc silicate coatings, utilize both of these concepts to prevent corrosion, initially operating as a sacrificial coatings and then becoming a barrier type coating.

Cotngs can also provide functions such as improving cosmetic appearance, protecting cargoes from contamination, preventing hull fouling and minimizing damages. Often, two or more generic coating types will be combined in a coating system to perform more than one function. Underwater hull coating systems. for instance, usually utilize a barrier type coating as the first two or three coats of the system to prevent corrosion, then additional coating(s) are applied to prevent fouling of the hull. A similar approach is taken to topside systems, where an inorganic zinc silicate is often used as the corrosion preventative primer. then topcoats such as alkyds, vinyls, urethanes or water based acrylics are applied to achieve the desired cosmetic appearance. In some of these topside systems, it is necessary to include an intermediate coat of epoxy to tie the topcoats into the zinc silicate primer coat.

Some specialize coating systems are used for a specific purpose. Coatings for cargo tanks of chemical carriers must, fix example, be resistant to the variety of cargoes that ship is likely to carry so as not to contaminate the cargo or reduce the effectiveness of the coating system. Specialized coatings are also used on areas such as the bow sections of icebreakers. These coatings are more resistant to damage from abrasion as the ship moves through icy seas, providing greater protection of the steel substrate.

There are many different generic coating types available to perform the functions required of coating systems. often there are many generic coating options to perform a desired function, as well as a variety of coating manufacturers from which to select. Part of the difficulty in understanding coatings is obtaining a working knowledge of the wide variety of coating options available and the relative merits of each coating and/or system.

For the most part, standard coating systems have been developed and are recognized as the best systems for most ship areas. However, the current changes in regulations and legislation applicable; coatings has created an atmosphere in which many of the tried and true systems are being modified or changed. This places an even greater emphasis on

coating knowledge.

The following provides a brief overview of some of the coating types routinely used in marine applications:

- **ALKYD - Alkyd coatings are physically drying** coatings which utilize oil based resins. These coatings can be usedas either a primer (with the addition of anticorrosive pigments) or as finish coats. Some primer formulations utilize corrosion inhibiting pigments such as lead and zinc chromates, which are considered to be hazardous to personal health and/ or to the environment. Alkyds can be formulated with a flat semi-gloss or gloss finish in a wide variety of colors and, since they retain their color and gloss very well, are often used as interior coaling systems or as topcoats for exterior applications.

Alkyd coatings are economical and easy to apply. They do, however, operate as a barrier type coating and have a relatively short effective coating life as a full system in severe environments. They do not stand up well in chemically corrosive environments. Alkyds modified with silicone produce an excellent exterior top coat which has good gloss and color retention and is easy to apply on a ship in service.

. ANTIFOULING - Antifouling coatings are applied to the underwater hull portions of ships to prevent the growth of marine life on the ship. While not technically a generic coating type, they represent a major consideration in marine coating applications since their performance (or lack thereof) can affect many facets of ship operation. These include

- efficiency of engine operation and fuel consumption
- time required for passages
- the need for time out of service prematurely (and the auxiliary cost associated with that necessity) to prolong coating life or apply additional coating

The prevention of hull fouling was originally required because of the damage that the fouling could have on wooden ship hulls. With steal Ships, the primary concern is the impact of fouling on the speed of the ship and fuel consumption.

These coatings have traditionally incorporated an antifouling pigment. usually some form of a biocide, into their formulation to prevent the attachment of fouling organisms. The most commonly used antifouling pigment is cuprous oxide. Other antifouling pigments, such as organotins, are also used, but have come under some scrutiny because of concerns regarding their possible impact on water quality and marine life other than hull fouling organisms.

The means by which the antifouling pigment is released defines the type of antifouling coating. There are two prevalent means by which this can occur: leaching and ablating.

The older, conventional type formulations incorporate high levels of antifouling pigments in a binder and rely on the natural tendency of those pigments to leach out of the binder. This is effective in the short term, Providing fouling protection for 12 to 18 months. The problem with this approach is that it is difficult to control the leach rates. Early in the life of the coatings, extremely high levels of pigments are released, much higher than is required for fouling protection. As the coating ages, the level ofleaching decreases, first to an appropriate level for fouling control, then gradually to ineffective level. It is at this point that hull fouling begins, even though there may still be a significant thickness of antifouling coating and volume of antiofouling pigment remaining on the hull.

CIeaning the coating using heavy duty nylon or Stainless steel brushes (also called scamping) can extend the life of these coatings by physically removing the outer, dead layer of coating. This exposes a fresher layer of coating which still has effective levels of antifouling pigment. While the expected level of performance of a cleaned antifouling is not as great as that of a newly applied antifouling, it does extend the life of the coating without the need for and expense of dry-docking, surface preparation and application of fresh coating.

Ablative antifoulings, introduced in the early to mid 1970's, revolutionized antifouling coating technology. While still utilizing an antifouling pigment for prevention of marine growth they also

provide a controlled means of release of the pigments. With these coatings, as the antifouling pigment is released, the remaining binder is loosely adhering and sloughs off, or ablates, as the ship moves through the water. Thus, a flesh layer of antifouling (and pigment) is always exposed as long as the ship is moving. This provides for a much more controlled and consistent release of antifouling pigments.

With these coatings, the life of the coating is a function of the thickness of the coating applied, the speed of the ship through the water and the ablation rate of the coating formulation. This technology has been refined to the point where coatings with different rates of ablation have been developed for ships of varying speeds, and the effective life of an antifouling can be five years or longer.

Ablative antifouling represents the current state of the art for antifouling coatings. The future direction of antifouling coatings appears to be the development of an antifouling coating which does not require an antifouling pigment, perhaps based upon this same ablative technology.

• **CHLORINATED RUBBER -** Chlorinated rubber coatings are solvented coatings which dry quickly and form an excellent barrier type coating film, with good resistance to water and some chemicals. They can be used as a full system as either a primer or topcoat, although the strong solvents in the chlorinated rubber coatings do have a tendency to soften and/or lift coatings with weaker solvent lineups. They are available in almost all colors and glosses. Use of these coatings is dimishing somewhat due to their (usually) high VOC content. In addition, epoxies are commonly used in areas where chlorinated rubbers would previously have been specified (i.e. immersion service and in splash areas).

• **EPOXY-Epoxies** are, perhaps, the most widely used coatings in the marine industry. They are an excellent barlier coating which is highly resistant to marine exposure. damage and a wide variety of cargoes. As such, it is often used as an underwater hull anticorrosive coating, a tank coating (for both ballast and cargo), as part of system on exterior decks and bulkheads, in bilges, and on interior bulkheads and decks.

Epoxies are usually two component coatings which achieve a chemical cure. Once the components are mixed together, chemical cross-linking of the coating begins. As such, epoxies have a pot life, or a defined length of time in which the coating should be used. Once the coating is applied to the substrate, the solvent (or vehicle) evaporates and the chemical cross-linking of the coating continues to completion. Depending upon the formulation of the coating and the ambient conditions, this process can take smatter of minutes or as long as several days. Polyamide epoxy coatings have become the most widely Used epoxy coating in the marine industry, although other epoxies, including ketamine, polyamine and amine adduct types, have also been used in marine applications.

While epoxies are excellent coatings, they do have some weak points of which to be aware. In exposure to ultraviolet rays (i.e. sunlight,) they have atendency to chalk. This is a situation in which the ***W rays*** break down the chemical bond on the outermost layer of the coating, resulting in a loose, chalky residue on the surface. Therefore epoxies are not usually recommended for use as a finish coak.

The chemical curing of the coating is very much affected by ambient conditions. Colder temperatures slow the rate at which the coating cures. Most early epoxy formulations were not recommended fox application below 50 degrees Fahrenheit. Below that temperature, the curing process slowed to the point where it effectively stopped. It is only recently that epoxy coatings have been developed which cure below freezing. Similarly, hot temperatures accelerate the curing process. Both of these factors will affect the time required between coats of a system and/or the time until the coating is placed into service.

The fact that epoxies chemically cure can also increase the waste factor associated with the use of the coating. Once the components are mixed, there will be a pot life during which the coating must be used. This pot life can be as short as 2 to 6 hours. After this time, the unused coating is not suitable for

use and must be discarded. Ambient temperature and conditions will also affect pot life.

Cured epoxy coatings usually become very hard. This can present problems when these fully cured coatings need to be top coated. Most epoxies have limits on how long a cured coating may sit prior to application of a subsequent coat without performing some surface preparation to roughen the surface. This overcoating interval applies to systems in which the epoxy is topcoated with another epoxy coating or with another generic type of coating, although the overcoating intervals may vary for different coating types and formulations.

Coal tar **epoxies represent a subset of epoxy coatings which** merit specific mention since they have been frequently used in marine applications. These coatings use a coal tar pitch in conjunction with epoxy resins to produce, perhaps, the premier barrier type coating. Coal tar epoxies are extremely strong and resistant to damages, and have been frequently used as anticorrosive coatings or as full systems on fresh water ships. These coatings do, however, present a potential safety hazard, as coal tar Is considered a suspected carcinogen. For this reason they have fallen into disfavor.

Coal tar epoxies are also undesirable as primers for systems in which cosmetic appearance is a concern, as the coal tar pitch will tend to bleed through most generic types of topcoats. They also can be difficult to topcoat since they become very smooth and hard. The presence of coal tar in the coating also limits the color selection available with coal tar epoxies. Coal tar is a brownish-black color, and coal tar epoxies are only available in brown or black.

Zinc rich epoxies are another subset of epoxies which are used in marine applications. In this formulation. zinc powder is added to the epoxy to provide some degree of sacrificial protection to augment the epoxy barrier coating. These coatings arc often used as the touch up or repair system for inorganic zinc coatings since they are considered easier to use than the inorganic zincs and can perform fairly well over a lesser degree of surface preparation.

• **INORGANIC ZINC -** Inorganic zinc silicate coatings represent a somewhat unique coating type in that they are initially a sacrificial type coating, then eventually become a barrier type coating. As a result, inorganic zinc coatings can provide excellent thin film, single coat corrosion protection. They have historically been used as a preconstruction primer, as a single coat system in tanks (product and ballast), chain lockers and on exterior deck and coaming surfaces, and as a primer for multicoat systems on exterior freeboards and topsides.

Inorganic zincs are available as a water based or solvented coating. While the solvented versions of the coating (utilizing an alkyl or ethyl silicate binder) have been the more popular and widely used inorganic zinc coating over the past 10 to 20 years, the coating type was originally developed as a water based coating. Most inorganic zincs require a curing process, often with an external stimulus to complete curing. Solvented inorganic zincs react with ambient moisture (usually humidity) to cure. Water based zincs can be either heat stoved, post cured with acid or self curing by reacting with ambient carbon dioxide. The self cure versions have evolved to the point where extremely short curing periods are required and the reliance on external stimuli has been reduced.

Most solvented inorganic zincs have, traditionally, been high VOC coatings. Reformulation efforts have reduced VOC content to levels which are currently acceptable with exemptions that are in place. It is doubtful that they will ever reach the mandated eventual requiremmt for all coatings of 240 grams per liter. They also may have low flash points. Water based zincs are very low VOC coatings, often at or near zero VOC and most have no point at which they will flash.

Inorganic zincs do not work well as ● single coat application in exposure to extremes of pH or when exposed to wet heat. Inorganic zincs also have the reputation for being difficult to use and for being unforgiving of substandard surface preparation.

• LATEX-Latex coatings appear to be the "heir apparent" to the oil and alkyd based coatings. Latex coatings are physically drying, water based erred**sions** which utilize acrylic or polystyrene butadiene resins. The toughness of the coating is enhanced by

the coalescence *of* the polymer particles overtime. These latex formulations produce an initial highly cohesive film which achieves adhesion to the primer or substrate more slowly. The coatings have good color and gloss retention and are most often used as interior and exterior finish coats, although primer formulations are also available. Latex coatings require good quality surface preparation and are not tolerant of chalky, dirty or glossy surfaces.

. **OIL** -Oil-based coatings represent some of the oldest coating technology still in use. Based upon either long or short oil resins, these coatings achieve good film thickness per coat and wet-out on the surface extremely well. This provides the coating with a certain amount of tolerance to less than ideal surface preparation. Oil-based coatings are slow drying, so they are primarily used for exterior applications, although dryers exist which speed the drying process. Oil based coatings are physically drying coatings which are not tolerant of chemicals, corrosives or solvents, nor are they abrasion resistant.

. **OIL-ALKYD -** Oil-based coatings are often combined with alkyd technology to produce a hybrid coating which embodies some of the desirable qualities of both. These include reduced drying times, improved leveling, hardness, gloss and color retention. These coatings remain easy to apply, achieve good adhesion and are flexible. Oil-alkyd coatings require improved surface preparation over that for straight oil based coatings.

. **URETHANE--** urethanes are generally thought to provide an excellent exterior finish coat which has excellent gloss and color retention, abrasion resistance and durability. There are, however, several different types of urethanes and not all formulations provide these qualities. Aliphatic urethanes are two component products that provide excellent color and gloss retention and durability, but are usually extremely high VOC coatings, especially the high gloss versions. Lower VOC urethanes, such as acrylic urethanes, are available which meet current VOC requirements. These are also two component products which provide excellent service in severe marine exposures and in exposure to UV. They are not. however, available in the super high glosses that are frequently used on larger pleasure craft.

Commodity

Oil modified urethanes are usu- ally single package products that are **often used as clear coats in floor finishing system and in lieu of varnishes on exterior applications. These pro-** duce a fast drying, abrasion resistant finish that can be applied to a number of different substrates. Moisture curing urethanes are usually single package products which cure by reacting with ambient moisture. However,they are not considered the equal of either the aliphatic or acrylic urethanes in terms of performance. They are, however, usually less expensive. Water based urethanes are also available, representing the latest direction of the urethane technology. These are fairly new products which are promising, though not yet fully proven.

Urethanes arc excellent coatings for finishes, durability and as a barrier coating. They are, however, not without their shortcomings. There are some safety concerns with the possible presence of free isocynates in urethane coatings as well as the strong solvents which are Often used with urethane coatings. Both of these factors should be carefully reviewed prior to deciding to use urethane coatings. Urethane coatings are often extremely high VOC coatings, perhaps higher than local regulations al-ddlow. Each of these factors vary depending upon the specific type and formulation of urethane selected for use.

Many urethanes form a hard, smooth finish which can be difficult to topcoat without additional Surface preparation. Some form of surface roughening is often required to gain acceptable levels of adhesion of topcoats. In addition, urethanes can present challenges in creating a cosmetically even finish. Application of other then a smooth even wet coat can produce noticeable diffences in finish and gloss. Likewise, areas of a urethane coating which have been touched up usually produce a noticeably diffent finish.

• **OTHER COATING TYPES -** Coating a ship can also require a multitude of other coating types for specialized applications. Most of these coatings are used in limited quantities to perform a specific and unique function. Therefore they usually represent fairly straightforward procurements. They are not, however, without their issues. For example, marking paints are required in a variety of colors for identification of specific ship systems or safety designations. These coatings have, traditionally, been alkyd type coatings and their use limited to stenciling or application to relatively small areas. However, the need for a variety of colors, and often bright and distinctive colors, have traditionally led to their formulation using lead or chromate pigments. With these now identified as potential safety problems for shipyard workers, marking paints have had to be reformulated to eliminate these pigments. The result is often a higher priced coating.

High **heat coatings and heat resistant coatings are another** coating which have become a concern. They have traditionally been silicone based coatings that are pigmented with aluminum to produce a coating that can withstand temperatures as high as 2000 degrees Fahrenheit. The problem with these coatings is that they usually possess a very high VOC content, well above the target standards established for all coatings. Attempts to reformulate these coatings have been unsuccessful. Therefore it will be necessary to identify replacements for these coatings.

Among the other coating types which may represent specialized procurements are coatings to apply over lagging, intumescent coatings, fire retardant coatings and anti-sweat coatings.

THE PROCUREMENT PROCESS

The coating procurement process consists of defining needs, preparing a request for quotation (RFQ), soliciting quotes and reviewing those quotes to determine which provides the best value to the shipyard. To accomplish this, some basic information is needed, such as what kind of coatings are required, what quantities are required and special color requirements. The basis for determining these requirements is provided to the shipyard in the coating or painting section of the ship specifications. These written specifications provide the owner's requirements for coating each ship area. This information must be reconciled against the actual ship design to assign the correct coating system to each ship area. Once this has been accomplished, the shipyard will usually attempt to determine what quantities of each coating type will be needed to coat the ship. It is from these cumulative efforts that an RFQ is compiled and quotes for the supply of coatings are solicited. Review of these quotes is then undertaken to evaluate each against the requirements of the shipyard and compliance with the requirements of the ship specification. Then a determination of which quotation provides the best value to the shipyard is made and the contract to supply the coatings is awarded.

THE SHIP SPECIFICATION

The painting or coatings section of the ship specification defines the coatings and/or coating systems to be used in each ship area. These requirements are usually written in one of three formats;

- a generic specification

* an "or equal" specification

. a "pre-approved" specification

In addition, the coating portion of the ship specification will define the thickness of each coating or coating system which is to be applied and will specify coloir requirements where necessary.

***The generic specification -** This identifies the generic coating type, the thickness of each coat and/or the system and the colors to be applied (where that is a concern). For example, a generic specification for the engine room bilge area might require two coats of a polyamide epoxy coating, with each coat to be applied at 4 mills dry film thickness and the final color to be red, The generic specification assumes that all coatings of a generic type are equal and provides few built in controls over the quality of coating ultimately selected and applied to the ship, either in terms of application characteristics or performance of the coatings. With this **type of specification, much of this** control is placed on the shipyard to evaluate the coating manufacturer and the quality of coating they produce.

• The "or equal" specification - This type of specification often reflects an owner's familiarity and satisfaction with one specific coating manufacturer and their coatings and systems. With this specification, it is usually the owner's preference to use the designated coatings. However, an "or equal" clause is included in the specification to preclude a sole source situation in the procurement process. The "or equal" specification will name the specific product(s) by company name and designation (followed by the words "or equal"), as well as specifying the thickness at which the coatings are to be applied and the color designation where appropriate.

For the engine room bilge example, this specification would specify "Coating X manufactured by Company A (or equal) applied at 4 mills dft per coat. Final color shall be red." Where the shipyard desires to use an "or equal" coating, it is incumbent upon the shipyard to demonstrate that the proposed system is the equal of the designated system.

•The "pre-approved" specification - These ship specifications will refer to material specifications or coatings lists which identify the coatings or systems which may be used. This is most frequently used in government procurements. This type of specification requires maintenance of the approved list of coatings, including provisions for new coatings/systems to be approved and deletion of those coatings which do not perform as desired. This maintenance effort can be an expensive and time

Consuming task.

Under this type of specificatiom the require-ment for a specific ship area, again using the engine room bilge area as an example, might be for a coating system meeting the requirements of DOD-P-23236 (final color shall be red) or a three coat system meeting Mil-P-24441 and consisting of prime coat of Formula 150 at three roils dry film thickness, an intermediate coat of Formula 152 at three roils dry film thickness and a final coat of Formula 156 at two mils dry film thickness.

There are two common types of pre-approved specifications, the formulation specification and the performance specification. Formulation specifications provide the formula or recipe for making a coating, providing the amount or range of amounts of each ingredient or component and the procedure for making the coating. Performance specifications identify a series & performance criteria which a coating or coating system must meet in order to be approved under that specification.

The DOD-P-23236 specification is a perfor-mance specification for proprietary epoxy tank coatings that is frequently specified as an alternative to the formulation specification of Mil-P-24441. In the DOD-P-23236 specification, the proprietary systems are tested in the number of coats and dry film thicknesses recommended by the manufacturer of the coatings and use of these systems must be in accordance with both the manufacturer's requirements and the number of coats and thickness for which approval was granted In this scenario, the shipyard is free to choose any of the coating systems which meet the DOD-P-23236 specification to coat the engine room bilge, or can choose the Mil-P-24441 system.

A ship *Specification can also refer* to several other specifications or lists to create a coating system. The freeboard area of ships is an example of where this can occur. A Navy system frequently specified for use on freeboards consists. generically, of a prime coat of inorganic zinc silicate, an intermediate coat of epoxy and two finish coats of silicone alkyd For this system, the specification could require

* the inorganic zinc to be approved under DOD-P-24646 (or be on the NAVSEA list of approved inorganic zinc coatings)

- the epoxy coat to meet the requirements of Mil-P-24441, Formula 151 (or an approved proprietary epoxy)

* the finish coats to meet the requirements of TT-E-490 or DOD-C-24635 (haze gray)

Selection of any of the coatings approved under each specification are acceptable for use in this specification. It would also be acceptable to use coatings from different manufacturers to compose this coating system.

DETERMINING BASELINE QUANTITIES

***Once the specification* interpretation has** been completed and the generic coating system for each ship area has been determined, it will be necessary to quantify the requirements for each type of coaling to be procured and applied to the ship. It should be stated early on that without significant and detailed historical data on coating consumption, it will be extremely difficult, if not impossible, to accurately predict the amount of coating required to coat a ship or a ship area.

For purposes of developing an RFQ, it is sufficient to provide a means by which an apples to apples comparison of the potential coatings can be made. To achieve this, it will be necessary to calculate the square footage of each area to be coated From this information it will be possible to calculate the quantities of each coating that would theoretically be required to coat that area. This "theoretical coverage" estimate makes no allowance for coating waste or for excessive mil thicknesses. Usually, a waste factor of 30 to 40% is included in this calculation to produce a "practical coverage" estimate of the quantity of coating required for a given area.

Unfortunately, not all gallons are created equal The amount of square footage that a gallon of coating covers is dependent upon the solids by volume of the coating and the thickness at which it is specified to be applied. These factors can vary significantly from one coating to the next Therefore,

the amount (gallons) *of* coating required to cover a given area can vary from coating to coating, even among coatings of the same generic type.

CALCULATING COVERAGE

Most coatings, in their liquid state, are made up of solids. a binder and solvents. The solids and binder are the portion of the coating which form the final coating film and provide protection to the substrate. As discussed previously, there are many different coating types, or solids and binder combinations, used to perform various tasks on a ship. The solvents, which in this usage includes water as well as the various petroleum based solvents, are used to create the liquid state in which coatings can be more easily transported and applied to the substrate. Once applied, the solvents evaporate and leave the solids and binder behind to form the final coating film. As such, there is a portion of each gallon of paint which, while performing a valuable function, does not remain on the substrate to contribute to the long term performance of the coating.

It is possible to accurately calculate the coverage per gallon of coating at a specified dry film thickness if the solids by volume of the coating is known. Fortunately, this information is provided on most product data sheets or is readily available from the coating manufacurer. This calculation is predicated on the fact that a gallon of coating that is 100% solids will cover 1604 square feet at l mil dry film thickness. This coverage figure is then reduced by adjusting the solids to that of the coating in question and adjusting the dry film thickness to that specified in the application. For a coating which is 55% solids and applied at 3 mils dry film thickness, the calculation to determine coverage is:

$$\frac{55\% \times 1604}{3} = 294.07 \text{ square feet per gallon}$$

The first calculation, 55% X 1604, adjusts the coverage per gallon of coating at one mil dry film thickness to that of a coating with 55% solids. This eliminates the solvents, which evaporate, from consideration. This coverage at one mil is 882.20 square feet per gallon. The second calculation, dividing by 3, adjusts the coverage to that of the specified three mils dry film thickness, or 294.07 square feet per gallon. This is the theoretical coverage per gallon, or the coverage for that gallon of coating if there was no waste and no deviation from the specified 3 mils dry film thickness.

Obviously, it is not practical to believe that this theoretical coverage achievable in any shipbuilding situation. Therefore, this figure is adjusted to account for some of the waste and deviation from the specified coating thickness. This waste factor is usually assigned a value of 30% to 40%. To adjust the theoretical coverage to account for this waste, the theoretical coverage must be reduced by the 30% to 40%. For the scenario created above, assume a 35% waste factor and reduce the 294.07 square feet per gallon by 35%. This can be accomplished by either of the following equations

294.07- (294.07 X 35%) = 191.15 sq. ft per gallon

or

294.07 X 65% = 191.15 Square feet per gallon.

The final step in the process is to use these overage rates to determine how much coating will be required to coat a given area. Assume that it is a product tank which has a surface area of 65,000 square feet that is to be coated. If the practical coverage of 191.15 square feet per gallon is used, then the equation is:

65,000 Sf / 191.15 sf/gal = 340.05 gallons.

The practical estimate is that it would require just over 340 gallons of coatings for that tank area. For a comparison assume that an alternate coating is available which is 80% solids and specified at three mils dry film thickness which can be used in place of the 55% solids coating. The calculations

$$\frac{80\% \times 1604}{3} = 427.73 \text{ sf/gal theoretical coverage}$$

and

427.73 sf/gal X 65% = 278.02 sf/gal practical coverage.

To coat the same 65,000 square foot tank surface, it would require 233.80 gallons (65,000 sf/ 278.02 sf/gal = 233.80 gal.) That represents a difference of more than 100 gallons to coat the same area.

Taking the scenario a step further, assume the 55% solids coating is priced at $ 16 per gallon and the 80% solids mating is priced at $18 per gallon. The total cost of material to coat the 65,000 sf tank is $5440.80 for the less expensive (per gallon) 55% solids coating and $4208.40 for the more expensive (per gallon) 80% solids coating. In this scenario, **using the "less expensive" coating would cost almost 3O% more than using the "more expensive" coating if only price per gallon were considered in the purchasing decision.** This example demonstrates that not all gallons of coating are equal and why it is essential to develop a means of providing an "apples to apples" comparison of proposed coatings in order to obtain the best coating value.

In addition to the increased procurement cost for the "lower priced coating," use of this coating could also result in:

- increased labor to appIy the coating
- increased warehousing costs
- the generation of more waste
- a greater environmental impact
- increased waste disposal costs for the ship yard

These factors would add to the overall cost of using what appeared, initially, to be the lower cost coating.

DETERMINING ACTUAL QUANTITIES

Part *of* the frustration and difficulty of dealing with coating as a commodity is that there are not definitive quantity requirements for a given ship or ship area. With most procurements, the ships' plans or drawings will identify a definitive requirement. With valves, for instance, a drawing will identify a set number of each type and size of value that will be required to build the ship. This will be a definite requirement that will not change unless the drawing changes or a valve is found to be defective or is damaged in production. This definitive requirement allows purchasing to proceed with the procurement of and negotiate for a known requirement. This is not the case with coating procurements.

As was stated previously, the calculated quantities of coating required will probably not represent the actual quantities required to coat the ship or a portion of the ship. Calculating the volume of coating required based upon solids by volume and a waste factor is used to provide a means of equally evaluating the price quotes provided by each vendor. For accomplishing this function, using a practical coverage method of quantifying coating requirements is sufficient. However, the goal for any shipyard should be to define the realistic quantities required for coating a given ship or ship areas. Accomplishing this will not only benefit the purchasing department in their solicitation of quotes for coatings, but will also provide:

- the estimating department with accurate information that wiIl be invaluable in their pursuit of future work
- the paint department with another means of identifying areas of waste and poor productivity
- the environmental group with accurate projections of coating usage, and, therefore, of VOC emissions and waste generation
- the receiving and warehousing groups with an accurate depiction of the requirements with respect to paints and coatings

Arriving at an accurate projection of coating requirements will entail a detailed review of the coating operation and the compilation of historical data to quantify typical coating usage for various ship areas and for various locations within the shipyard where coatings are applied. This process will require a level of detail that is. in all likelihood, not currently in place within the shipyard data collection effort. Among the consumption factors which must be tracked and quantified are:

•**ACTUAL WASTE** - It is a fact that a certain portion of every gallon of coating is wasted. While an arbitrary factor is included in most calculations of projected coating usage to account for waste, these factors may not accurately reflect the actual condition in the shipyard. Most coatings in a shipyard are applied by spray and the process of spraying coatings is an inherently wastefull process. This is especially true of coatings applied outside, where wind can increase greatly the amount of coating which does not reach the substrate.

For each coating used and each area within the shipyard where coatings are applied, a diffrent waste factor may apply. An attempt to quantify these waste factors will provide a much more accurate estimate of coating consumption. In addition, it can identify coatings, processes and/or areas within the shipyard that are excessively wasteful. This information can be used to justify a change in coatings used for a specific purpose, change the process used to apply the coatings or the location in which coatings are applied. Either change will reduce coating usage and improve the efficiency of the coating operation.

Waste also exists in coating which is not used and either is not returned to the storeroom or. in the case of catalyzed coatings, has a pot life which is exceeded before it can be used. In both instances, it is to the benefit of all to identify recurring sources of this waste and minimize the frequency with which they occur.

•**DEAD VOLUME** - Each surface preparation operation produces some surface profile or roughness. For abrasive blasting operations especially, this roughness can be quantified in terms of mils of surface profile produced. Surface profile is. essentially, a series of peaks and valleys created on the surface of the steel to enhance the adhesion of the coatings to the substrate. These peaks and valleys can measure as much as 4 or 5 mils from the valley to the peak. There will, obviously, be some volume of coating required to fill these valleys, not all of which will be measured using traditional dry film thickness measurements. This unmeasured coating is the dead volume. In order to accurately project coating usage, this dead volume must be included.

***The* amount of coating required** to fill the dead volume IS dependent upon the surface profile over which the coating is being applied and the point at which dry film thickness gauges begin to measure coating thickness. Unfortunately, there are no hard and fast answers to either of these baseline factors which define dead volume. Measurement of surface profile is an imprecise art which can vary greatly from one measurement method to another and it has not been definitively established at what point in the peaks and valleys of surface profile that dry film thickness gauges begin to measure coating thickness. However, some means of determining dead volume must be establish even if it is done as an "educated guess."

Some assumptions and trust may be required to quantify the dead volume coating consumption. First, a means of determining surface profile must be established and used consistently. While the various means of determining profile do not necessarily correlate to one another, each method is fairly consistent in identifying the surface profile. Second, an assumption must be made as to where dry film thickness gauges begin to measure coating thickness. This is probably not at the top of the highest peaks nor at the depths of the lowest valley, but somewhere in between, most likely it is relatively close to the top of the peaks, perhaps 25% down. Using these assumptions, a calculation can be made to quantify the dead volume.

$$\frac{\text{Surface profile} \times .75}{3} = \text{Coating thickness (in mils) required to fill the dead volume}$$

***From* this calculation, the *quantity of* mate**rial (in gallons) required to fill the dead volume can be determined by first determining the coverage of the coating at the specified coating thickness (in this case the thickness is that derived from the dead volume calculation):

$$\frac{1604 \times \text{volume solids}}{\text{coating thickness}} = \text{theoretical coverage (sf/gal)}$$

Then, adjusting the coverage figure to account for a waste factor:

Coverage minus 30% waste factor = Practical coverage (sf/gal)

And finally, the quantity in gallons required to fill the dead volume can be calculated dividing the area to be coated by the coverage per gallon:

Area (sf)/coverage (sf/gal) = Coating required (gal)

To demonstrate this using real numbers, assume a surface profile of 3 mils, a 60% solids coating, a waste factor of 30%, and an area to be coated of 100,000 square fret. The calculations are:

$$\frac{3 \text{ (Surface profile)}}{3} \times .75 = .75$$ *roils (coating* thickness required to fill dead volume)

Then:

$$\frac{1604 \times 60\%}{.75 \text{ (coating thickness)}} \text{ (volume solids)} = 1283.2 \text{ sf/gal (theoretical coverage)}$$

And:

1283.2 (coverage) - 384.96 (waste) = 898.24 sf/gal (practical coverage)

And finally:

100,000 sf (area)/898.24 sf/gal (coverage) = 111.33 gal (coating required)

In this scenario, it would require 111.33 gallons of coating to fill the dead volume created by a three mil surface profile. This would be in addition to the coating required to meet the specification requirement. If that requirement were 3 mils, the coating required to achieve that thickness would be approximately 450 gallons (the same parameters as were used in calculating the dead volume). The coating used in filling the dead volume required an additional 24.7% coating over the calculated practical coverage, a significant additional requirement.

It should be noted that this dead volume coating usage is only applicable to coatings applied over prepared substrates with surface profile. Obviously, the smaller the surface profile, the less coating will be required to fill the dead volume.

. EXCESSIVE COATING THICKNESS - All calculations to determine quantities, whether theoretical or practical. are targeted to a specific dry film thickness. These target thicknesses are usually the minimum allowed by the specification. As such **the actual coaling that is applied will exceed these minimum thickness requirements** by some amount. In order to determine the actual volume of coating required to coat a given area. it will be necessary to quantify this excess coating thickness.

The historical performance of the painting department will provide the best insight. It may be necessary to track average coating thickness for each coating used and for a variety of differet types of spaces or areas in order to arrive at accurate estimate of actual coating thickness versus specified coating thickness. quantifying this performance history can also identify areas that can be targeted for improvement, be it in the use of a specific coating types or in a specific area of the shipyard (or on board ship) where coating consumption is particularly **high.**

This factor would be expressed as a percent-age which would be added to the baseline quatity of coating or could be added to the waste factor by which practical coverage per gallon is calculated.

. REWORK - Perhaps the largest and most difficult to quantify use of coating occurs in rework. Areas which have been coated and subsequently damaged as a result of a dditional work performed by other trades will require repainting. This can often require repainting of an entire area or space in order to return the space to the desired appearance. Rework not only requires additional coating. but also reflects waste in the shipyard. Identifying areas of rework also identifies areas in which the production process is either not as efficient as it could be or in which change orders have an additional cost impact. The ultimate goal is to eliminate rework by improved planning.

Where coating rework is required as a result of a change order, the cost of this painting rework (materials and labor) should be included in the cost estimate for that change and rolled over to the paint department budget for that area. Most if not all changes will require some level of paint department rework.

. **COSMETIC COATS -** Additional coats of paint applied for purely cosmetic reasons will increase the anticipated coating consumption greatly. The coats are often applied just before launching or delivery to dress up the ship. The impact of these coats, not only on coating usage, but also on man-hours, can be significant. This impact should be quantified so that the real cost of a cosmetic or "dress up" coat of paint is known.

SOLICITING QUOTES

The document which requests pricing from the various coating manufacturers is a request for quotation, or RFQ. This document can encompass the coating requirements for a full shipset of coatings, for a flight or series of ships, or can be for small quantities of specific-use coatings. What ever is the case, it is also important that the structure and format of the RFQ be such that the differing coverage rates for coatings are taken into account and that certain yard-specific information be included in the RFQ to allow for a fair and equal competition among all potential vendors.

It is evident that not all coatings are created equal and that a gallon does not necessarily equal a gallon when referring to coatingcoverage.

These differences must be factored into the purchasing decision. Unless all coatings being solicited are of equal volume solids (as would be the case for formulation specification coatings), then it is not sufficient to solicit bids based on an assumed gallon requirement for a project. Where that appreach is followed, it is likely that the low bidder will be the lowest solids coating and that the actual coating usage will be greater than anticipated. The end result is increased material cost to complete the project.

An effective **approach to resolving the inequity** of coatings and their coverage rates is to **solicit bids based upon the mil square feet to be coated** rather than a gallon requirement. Designing a bid proposal which defines each ship area, the coatings or systems for that area and the square footage to be coated will accomplish this goal. The intent of this approach is to arrive at the gallon amount of each coating that will be required to coat the ship based upon the parameters established in the bid proposal. This information, along with the price per gallon, will allow each coating and/or system to be evenly and fairly compared and evaluated. Using the tank coating scenario developed earlier, the bid proposal entry for that ship area could resemble the tables shown on page 20.

FOR A GENERIC SPECIFICATION

SHIP AREA Product Tank SURFACE AREA: = 65,000 SF
COATING REQUIREMENTS: 2 Coats of polyamide epoxy @ 4 roils dry film thickness per coat

PROPOSED SYSTEM

Coating designation [Product name & no.)	solids Vol	Theoretical Cov. (sf/gal)	Gal. req.	Waste (+35%)	Total gallons required	Price @ gal	Total cost

FOR AN "OR EQUAL" SPECIFICATION

SHIP AREA: Product Tank SURFACE AREA: 65,000 SF
COATING REQUIREMENTS: 2 Coats of 123 Epoxy manufactured by XYZ Paint Co. (or equal) @ 4 mils dry film thickness per coat

PROPOSED SYSTEM:

Coating designation (Product name & no.)	Solids/ Vol	Theoretical Cov. (sf/gal)	Gal. req.	Waste (+35%)	Total gallons required	Price @ gal	Total cost

FOR A "PRE-APPROVED" SPECIFICATTON

SHIP AREA: Product Tank SURFACE AREA: 65,000 SF
COATING REQUIREMENT: Epoxy coating meeting the requirements of DOD-P-23236 or DOD-P-24441 (F15O@3 roils dft/F152@3mils dft/F152@2mils dft) DOD-P-23236 coating systems shall be applied in the number of coats and the thicknesses for which QPL approval was granted

PROPOSED SYSTEM:

coating designation (Product name & no.)	solids/ Vol	Theoretical cov. (sf/gal)	Gal. req.	Waste (+35%)	Total gallons required	price @ gal	Total cost

This format will provide the shipyard with an apples to apples comparison of the coatings proposed by the coatings manufacturers from which quotes are solicited. All that is necessary is to multiply the "quantities required" by the price per gallon to arrive at the cost of coating for a given area and for the entire ship. It also provides the coating manufacturer with some degree of latitude in proposing coatings which might provide some advantages to a particular shipyard because of productivity benefits, climatic influences, familiarity or other reasons.

OTHER RFQ CONSIDERATIONS

In addition to identifying the specific coating requirements for the project, the RFQ should provide additional information that is pertinent. This includes any information which could affect which coatings or systems a coating manufacturer would propose, impact the performance of those coatings specified or affect the competitive position of any vendor. This information may not be readily available to those responsible for assembling the bid proposal (usually the purchasing department). It is incumbent upon purchasing to assemble representatives from all shipyard groups who will be affected by the selection ultimately made in the coatings procurement process.

Communication within the shipyard is not always at the level it could or should be, so this provides an opportunity to enhance the interaction between shipyard groups and improve the effectiveness of all involved. Where communication up front can eliminate problems or conflicts down the road, it is to the benefit of all involved and makes the shipyard more productive.

Some of the issues that should be discussed and information provided to potential vendors can include:

• **SINGLE VENDOR VERSUS MULTIPLE VENDORS** -the shipyard must consider how they intend to proceed with the procurement of a shipset of coatings. It may be most desirable to purchase all coatings (or the vast majority) from a single vendor rather than from two or more vendors. Where the use of more than one vendor is not an issue, it will be necessary to decide how and where the use of different vendors will be acceptable.

While it is not unusual that coatings from more than one vendor are used to coat a ship, it is unusual (exept in the case of mil spec coatings) that coatings from more than one vendor are used in a coating system for an area. Where coatings from multiple vendors are mixed in a system, there is the potential for arguments over liability if a failure occurs with that system. This can lead to much finger-pointing and allegations regarding responsibility for the failure and, subsequently, over who bears the cost of repairing the failed system. If coatings from multiple vendors are used in a system, these issues should be addressed in advance.

. **FLASH POINT LIMITATIONS** - many yards impose minimum flash point requirements for all materials the are to be used in the shipyard. These restrictions should be stated up front so that appro priate coatings can be specified.

• **HAZARDOUS MATERIAL RESTRICTIONS** - most yards now impose strict limitations on materials which are considered hazardous or potentially hazardous to shipyard workers and their safety. Lead and chromates are specific examples which are closely controlled. Other materials, such as free isocynates in urethane coatings may also be controlled, as well as some specific solvents or coating formulations or generic types. These restrictions should be identified in the RFQ to avoid problems later.

• **PRODUCTION PROCESS REVIEW** - a brief review of the production process as it relates to coatings should be provided. This overview will allow coating manufacturers to better tailor their systems to the production requirements of the yard. Issues such as modular construction, blast and paint plans and schedules, topcoating interval requirements and launching and dry-docking plans should be included as appropriate.

•**PRECONSTRUCTION PRIMER-many** yards apply a standard preconstruction primer to steel used in shipbuilding process.
This coating should be identified and expectations with respect to compatibility should be stated.

•**PERFORMANCE AND GUARANTEE REQUIREMENTS** - where guarantees are provided by the shipyard to the ship owners, the parameters of these guarantees and any responsibility that will be assigned to the coating manufacturer in terms of performance should be stated.

TECHNICAL SERVICE AND SUPPORT - the expectations of the shipyard or requirements imposed by the ship owner with respect to technical support and service should be stated. This could range from full time technical support during all phases of surface preparation and coating application to tech service on an as needed basis to resolve discrepancies or problems.

• **STANDARD APPLICATION EQUIPMENT AND PRACTICES** - the equipment and practices that are standard in the yard should be stated to preclude or identify up front any changes in standard practices or specialized equipment which use of a coating or system will require.

•**ENVIRONMENTAL REQUIREMENTS** - any environmental restrictions that proposed coatings will have to meet should be stated. Specifically, this would include VOC restrictions in place at the yard and regulations in place for disposal of specific wastes.

. **DELIVERY AND/OR WAREHOUSING EXPECTATIONS** - the expectations of the shipyard with respect to availability of the proposed coatings, delivery requirements, warehousing conditions and space within the yard and documentation requirements for the coatings provided should be stated. In addition, payment terms, consignment requirements and return requirements should be addressed.

THE DETERMINATION OF VALUE

One goal of a purchasing agent is to identify quotations which provides the best value to his company. Accomplishing this requires that those factors which comprise value be identified, the relative importance of each be established, and each quotation evaluated based upon these factors and their relative importance to determine which provides the greatest value.

coatings procurement should not differ in process from the procurement of any other commodity. Good purchasing practices will determine the best coating value fix any given shipyard. The difficulty comes in getting coatings, as a commodity, into terms to which standard purchasing practices can be applied. Accomplishing this requires Input and valuations from a variety of shipyard groups and departments regarding the proposed coatings. In addition, most ship specifications require a wide variety of coatings and coating types to be procured and applied to designated areas on a given ship. This can make the coatings procurement process a challenging task. As such, it is a process which needs to be managed effecively to provide the shipyard with the best coating value.

With such a complex task, it is not surprising that a wide variety of input and expertise is required to determine the best coating value for the shipyard. It Is rare, if not impossible, that one individual or group will be able to correctly address and evaluate all of the factors which must be considered in the procurement process. Communication with those who can provide insight and analysis in their specific areas of expertise is essential to arriving at the proper determination of value. This communication is a key factor in the coating procurement process and, since it is the purchasing group whine task it is to make the procurement, it is they who should assemble and direct this communication. In short, they must manage the process in conjunction with the paint department

As is the case with any procurement, some factors will be more easily quantiflable than others and the weighting given to some factors will be greater than for others. There is no single formula which can be applied across the board to obtain the best coating value for all shipyards. Just as each shipyard's facilities and production Processes vary, so will their ability to quantify factors and the relative importance of each factor to be considered in the determination of value. Each factor must be examined, input solicited from those who will be affecd by the ultimate decision and agreement reached regarding the quantification of factors and relative weighting of each factor.

It is the purchasing group's responbility to be proactive and promotecommunication within the shipyard in order to make effective decisions regarding coatings procurement. The first step in this process comes during the development of the request for quotation where baseline requirements from each group or department were solicited for Inclusion in the RFQ. This is the first step in establishing the communications chain which will determine the best coating value for the shipyard. This **communications** chain should remain intact through the quotation evaluation process and through actual use of the coatings.

DEFINING VALUE

The factors which influence the determination of value in paints and coatings can be numerous and varied. In order to arrive at the best paint and coatings value, it will be to identify the factors which are pertinent to each shipyard and the relative importance of each factor. This can include all orrelatively few of the general purchasing factors which were discussed previously. The following provides a discussion of each factor in the context of paint and coatings as the commodity.

•**PRICE - The** cost of coatings tends to be the one factor which Is most frequently looked at in the determination of value. Cost can be one fictor which is readily quantiflable and easily compared. It is, however. essential that this comparison be made on an equal basis in order to identify the most cost effective coating or system for a given area.

A straight per gallon price comparison Will not provide an equal comparison of the cost of using those coatings. This must be accomplished by making the comparison on the basis of total cost (cost per gallon tines total gallons required to coat a given area or the ship) or upon the cost per square foot for each coating or system. IdealIy, both of these methods will be used to arrive at a true picture of cost. Either or both of these means of arriving at an “apples to apples” comparison of cost can and should be incorporated into the request for quotation.

The determination on the part Of the ship- yard as to how many vendors will be usedontheship and how the ship Will be divided among those vendors becomes very important in evaluating the price quotes. If only one vendor will be selected, then the total cost of all coatings and systems is the key cost figure. A single vendor for each ship greatly simplifies the evaluation of the cost factor. However, it may not provide the lowest overall cost for the ship since each vendor will tend to place their emphasis and, therefore most aggressive pricing, on different coatings and systems. By selecting the lowest pricing for each ship area, it is likely that a lower overall cost for coatings can be obtained. However, this approach can lead to increased costs in other areas such asreceiving Warehousing and handling.

When multiple vendors will be used, then cost per mil square foot for each area and total cost for that area will be important. The evaluation of the quotations must be made for each of those areas into which the ship has been divided and a separate purchasing decision made for each of those areas. It is also possible that, where initialI it was the intent to use a single vendor. the price quotes may identify a means of significantly reducing coating material costs by switching from a single vendor to multiple vendors. This can occur when vendors pursue aggressive pricing for specific systems on some ship areas and not on other. However, where quotations were solicited on the basis of a single vendor for the ship and the desire changes to the use of multiple vendors, then this Information must be provided to the vendors along with an opportunity to adjust and resubmit their quotations.

vendors win tend to set their pricing in relation tothe quantities they anticipate selling. The higher volume coatings may well be priced more aggressively than those for which there is smaller volume required. This is an instance where the cost per square foot method of comparison can be misleading. Where there is only a small volume of coating required, what seems to be a large disparity in cost per square foot may result in a negligible impact on total cost.

Given the difficulty in accurateI estimating coating requirments for a ship or ship area, contingency plans should be made and negotiated up front for dealing with overages and shortages. Where excess coating has been procured and not used, the means of returning that coating and the cost of restocking should be clarified. At the other end of the spectrum, the availability and cost of coatings above that initially contracted for should also be addressed as part of the negotiations.

The evaluation of the cost of coatings is not limited to the coatings themselves. Ancillary costs associated with the use of any coating must also be factored into the total cost evaluation. Primary among these considerations IS the impact that the selection of a coating or system will have on labor costs. Aclassic example of this is the use of a coating system which can be applied in two coats versus one which requires three coats. While the material cost for the three coat system may beless than that of the two coat system, the added labor to apply an additional coat of paint is likely to easily offset any material cost savings. Thus the total cost of the two coat system would be less than that of the three coat system. Similar examples of this include coatings which use less productive application equipment (resulting in increased man-hourstoapply) or equipment which is less effIicient (resulting in greater waste).

Other added costs can in clude Solvents which must be purchase for thinning and cleanup (and be disposed of), any special equipment required for applying the coatings, and any other added costs which will impact the total cost of using a coating or system.

. DELIVERY - The best coating value is useless if it cannot be delivered when and where it is required for use by the shipyard. Therefore, delivery Is an essential part of the value equation. Delivery is the

ability of the vendor to respond to the requirements of the buyer. Given the sometimes hectic and often changing production situation with respect to coatings, some planning and thought must be given to theon time delivery of coatings. If not,procurements will have to be made in which extremely short lead time delivery is the overriding consideration. This can, and often does, lead to paying a premium price for the coating.

There are several means of addressing the delivery issue in order to minimize its impact on the coating selection process. Perhaps most common is the standard system of establishing the lead times for each coating used and the shipyard being responsible for planning far enough in advance to get coating in the yard to support production. In a perfect world, this system is effective, however, a shipyard seldom reflects a perfect world. For a system such as this to work, a great deal of communication must take place not only between the shipyard and the vendor, but also within the shipyard to identify future requirements. In this situation, it is incumbent upon the shipyard to provide adequate warehousing facilities for storage of the coatings.

As an alternative, some shipyards will require the vendor to establish a stock point within close proximity to the Yard. The intent of this to provide for short lead times for delivery. This essentially places much of the burden for warehousing and inventory control on the vendor. For this to be effective, the stock point must have on hand those coatings in the quantities required to support the shipyard. Again, this will require extensive communications between the vendor and the buyer.

Another alternative is one in which the shipyard will work with a vendor on a consignment basis. In this arrangement the vendor coatings arestored in the shipyard's facility and used by the shipyard. Then the amount of coating used is counted at the end of each month and the shipyard will. in effect invoice itself for the coating used the previous month. This allows the shipyard to pay for their coatings after they use them, giving them use of their money for a longer period of time. It also requires that the shipyard dedicate greater warehouse space for coatings as well as to place more of the burden upon the shipyard to have on hand the coatings which they will be using.Therefore lead times are still a consideration.

Historical performance for delivery should also be a key factor in evaluating each vendor. A history of consistent. on-time delivery andready response to special needs should be given considerable weightin the evaluation of the delivery factor.

. QUALITY -Quality can be an elusive factor to define and even more difficult to quantify. Even the best coatings must be applied over the proper surfhcepreparation and under the proper conditions to provide the type and length of service expected. Whether this has occurred is often a source of controversy. Most, if not all, of the coatings which are marketed and sold by established and reputable coatings manufacturers are of consistently high quality. This does not preclude the occurence of instances where a batch of lower quality material is made and shipped. These instances should be few and far between. Where this does occur, it is incumbent upon the coating manufacturer to"dutherightthing" to rectify the situation.

An effort should be made to define quality prior to using any coatings. The baseline consideration in this definition is that the coating or system is appropriate for the service into which it is to be placed. A coating or system placed into service for which it is not recommended will most certainly not perform as intended. Beyond that from a shipyard perspective, the coating should be able to be applied over the standard surface preparation methods used in the shipyard, with the standard application equipment used by the yard and in the various environments of the shipyard. Applied under these conditions and parameters, the coating should provide the level of performance expected by the owner and promised by the vendor. Any deviation from this expectation should be identified prior to the purchase and application of the coating(s) in question.

Having established that the coating is appro- priate for the service into which it is being placed and that it will perform as expected under the conditions which exist in the shipyard the qualtiy issue is more clearly defined. The remaining considerations with respect to quality are issues which,for the mostpart, can only be defined through experience. The ability to achieve the desired coating thickness in the expected number of coats, the behavior of the coating in the various climatic conditions of the shipyard, the ability of the coating to mesh (in terms of recoat intervals) with the expectations of the shipyard and familiarity with the coatings are all considerations which reflect quality to a yard and which Can only be answered through using the coating(s).

Quantifying the quality considerations is diffi- cult. If is known that all or some of the coatings meet the requirements that define quality to a shipyard, then they should be rated highly with respect to quality. Unfortunately, coatings or companies with which a shipyard is unfamiliar may be rated lower, not because of a lack of quality, but because of a lack of familiarity. In that case, the reputation of a vendor or references from other shipyards may be used to assess these quality issues. Howwer, shipyads tend to Stay With known vendars in order to avoid problems associated with poor quality or the perception of poor quality. These problems can have a significant impact upon manhours and material consumption where additional coats are required to achieve the required coating thickness or additional surface preparation (orwaiting time) is required to establish the proper level of quality for the system or to repair a situation of poor quality.

. **VENDOR SUPPORT SERVICES** -There is a wide range of services which a vendor can provide to assist the shipyard in producing a cost effective and high quality coating application.
These can include

. assistance with the development of the paint schedule or other documents

. assistance with the development and pursuit of changes to the coating specification

. assistance in the resolution of possible quality discrepancies

•the training of persormel

•technical support during application of coatings

The provision of these and any additional support services should be discussed in the RFQ and either included as part of the quotation (at no additional charge) or quotations solicited for providing any sercices required.

Once the vendor support requirements are established and cost issues resolved, then it is necessary to evaluate the abilily of each of the vendors to provide the services required. As with the quality factor, much of this evaluation will be based upon familiarity with the vendor and the shipyard's Perception of the vendors ability to provide the required services. Failing that first hand knowledge, the shipyard may rely on the reputation of the vendor in the marine industry or upon Input solicited from colleagues at others shipyard the ability of a vendor to provide the required level of support.

• **WAREHOUSING/INVENTORY MANAGE—MENT-Perhaps** the most important factors relating to warehousing and inventory management is the number of vendors and the number of different coatings that will be used on a given ship. Where two or more vendors are selected, the requirements for warehousing and inventory control are increased greatly. An attempt should be made to quantify those increased requirements prior to making a decision to use more than one vendor on a ship. In addition, a proposal which requires an excessive number of different coatings to coat the ship will require more warehousing and handling. This Will also result in increased costs.

Warehousing and inventory management are also related, in part to the delivery issue. When a shipyard requires a vendor to provide short lead time delivery from a near stock point the warehousing and inventory management functions are greatly reduced. Where this is not a requirement and a vendor can still provide this service, then that vendor has a distinct advantage over other vendors and should be given due consideration for that advantage.

The *importance* of warehousing and inventory management will hinge on several additional

Ž **The number of different coatings** and systems used on the ship. The greater the number of different coatings, the greater the burden on ware housing and inventory Control.

. **The shipyard climate** and the storage requirements for each coatings. Where specific orrestrictive storage requirements are required for some coatings, these can incur additional costs for the shipyard. In addition the ability of The shipyard to provide adequate storage conditions, both short and long term, for the coatings with their existing storage facilities should be evaluated.

Ž **Shelf life for the coatings** -While one year is a standard shelf life for coatings, the shelf life of all coatings should be identified. In addition, the ability to and process for recertifying coatings for additional shelf life should be define Consideration should also be given to defining what portion of the shelf life must remain for the coatings upon receipt in the shipyard. This is to avoid instances where coatings with little or no shelf life remaining are delivered to the shipyard.

•**ENVIRONMENT -** This is a major consideration in the evaluation and selection of coatings. Limits have been established for the allowable level of emissions of Volatile Organic Compounds (VOC) from coatings used in the marine industry. This has caused a great deal of change on the part of suppliers of marine coatings to provide coatings which meet the requirements of the established regulations. In addition, disposal of waste generated in the use of marine coatings has also come under increased scrutiny. This has resulted in increased costs for waste disposal.

A clear picture of the environmental require-ments and restriction must be developed andincorporated into the evaluation of coatings proposed for use in the shipyard. These requirements may differ, and perhaps differ greatly, from one yard to the next. In addition, environmental concerns are constantly changing, so constant attention must be focused on the evolution of environmental regulations. This Will,in all likelilhood,r equire the expertise and input *of* an environmental specialist to adequately evaluate and interpret the current state of environmental regulations.

Each proposed coating or sys-tem must be evaluated against the guidelines establishedwithintheship yard for environmental compliance. This compliance can be accomplished on a pass/failbasis (the coating either meets the requirement or doesn't) or can be evaluated and graded based upon the level of compliance each proposed coating achieves. The decision as to how these environmental evaluations are made may depend on the location of the shipyard, the environmental situation at that Iocation and the level of activity and involve ment of the local regulatory agencies.

With respect to Voc emissions, resections are inplace in most, if not all, locations in the U.S. Most manufacturers have coatings which meet these restrictions and routinely quote these coatings. This provides some built in controls on the VOC emissions for the shipyard. These restriction may be augmented by additional restraints placed on the shipyard for the total volume of VOC (in tons per year) they may emit. Where this level of restriction is in place. much more attention must be paid to the VOC content of each coating specified for use. In this situation every effort should be made to use the lowest VOC coatings available, since exceeding the total allowable emissions can result in substantial fines. Where there are fairly stringent restrictions on emissions, it may be advantageous to the shipyard to become profident in the use and application of lower and zero VOC coatings. This may require the shipyard to be aggressive in identifying coatings which meet their requirements and may result in some initial increased application costs while enduring a learning curve for use of these coatings.

Disposal of waste is a factor which is often overlooked in evaluating coatings. These costs can be substantial and will, likely, increase. An added factor in the disposal issue is that waste that is

disposed of properly under current regulations may be deemed improperly disposed of under future regulations. Where this occurs, it may still be the responsibility of the shipyard to properly dispose of this material. This will mean additional cost for the second disposal and possibIy fines which can be substantial. It is important that each coating proposed for use in the shipyard be looked at with an eye towards the disposal of wastes generated in the use of that coating, the cost of disposal and the potential for future problems as a result of that disposal. This is an area in which the input and expertise of an environmental specialist will be essential. This is especialy since this evaluation may depend, in part, upon conjecture regarding the future direction of waste disposal.

Another aspect of waste disposal the packagin in which coatings are delivered. Typically, coatings are provided in 5 or 10 gallons units, most often plastic or metal pails. These pails, which often contain residues of the coating, must be disposed of by the shipyard as waste or, in some cases, hazardous waste. Minimizing or eliminating this waste should be a consideration in evaluating coating proposals. Coatings may be delivered in larger packaging units, such as 55 gallons drums, or in totes or liners which are reusable. Each of these options will reduce disposal costs and, therefore, the overall cost.

Ž **SAFETY** - Safety issues revolve around the safety of the workers using the coatings and the impact of the use of coatings on the overall safety of the shipyard. Each yard should have established safety practice with respect to coatings which can include:

- minimum flash points for coatings
- personal protection apparatus for those using and in proximity to the use of coatings
- guidelines for handling and using Coatings
- ventilation requirements
- restrictions on the use of certain generic Coating types, certain pigments or components of coatings or certain solvents

Each *coating proposed for use* must be evaluated for compliance with the safety requirements of the shipyard. Coatings which do not meet these requirements maybe eliminated from consideration or the impact of using these coatings quantified and factored into the equation. This represents an area in which the input and expertise of the shipyards safety department should be solicited. Safety is an area of consideration which can have serious and substantial impact if not thoroughly evaluated prior to using any coating or system.

• **VENDOR STABILITY** - This issue relates primarily to the ability of the vendor to provide support, be it technical. financial or legal, throughout not only the construction of the ship, but also through the duration of any guarantee or warranty periods, be they expressed or implied. It also relates specifically to the financial ability of the vendor to"do the right thing when problems arise which require correction. Where correction of deficiencies or probIems are droned to be the responsibility, either whole or in part, of the vendor, they must have the resources to support the work to correct the defidency.

For most established coating manufacturers, the question of stability should not be an issue. However, in this era of change in the coatings marketplace, many newer manufacturers exist who may have products which appear to be desirable to the marine industry. Use of the coatings of these manufacturers may require a closer look at the stability of these companies and, perhaps, an evaluation of their long term stability based upon limited information.

•**VENDOR PERSONNEL** - The stability of a vendor in terms of the people who call on the shipyard, either in a sales or technical service capacity, can have an influence on vendor selection. Sales and service staff who are familiar with the needs and precesses of the shipyard can preclude the use of undesirable products, and the attendant costs of using those products. where personnel are constantly changing and enduring a learning curve with respect to the shipyard processes, there Isa potential for misunderstandings and disagreements with regard to the matings used or the surface preparation required for the use of those coatings. Vendor familiarity and stability can help prevent these

occurrences, and there is certainly a greater comfort level in working with the same people consistently.

• **GUARANTEE/WARRANTY** - Each vendor will provide some commitmentas to the merchant ability and fitness for use of their coatings. These should be reviewed for compliance with the requirements of the shipyard. The shipyard may also seek an additional commitment from a vendor for the performance of a coating or system in a specific service. The vendor's response to these requests should also be carefully reviewed as part of the selection process.

Most shipyards will provide the ship owner with a general warranty on the ship and its systems, includlng coatings, for a period of time after delivery. The duration of this warranty can vary, although one year is a standard. Obviously, the shipyard wilI require the support of the coatings vendor regarding the performance of their coatings throughout this period. Discussion Of this warranty and the expectations of the shipyard with regard to the vendors should be conducted as part of the vendor selection process and the vendor's responses evaluated for compliance with the requirements of the shipyard.

• **LEGAL/REGULATORY** - This factor has, perhaps, been a minor consideration in the vendor selection process. However. with constantly changing environmental regulations and potential worker safety issues, the legal and regulatory responsibilities of the coatings vendor (as defined by the contractual documentation which is part of a contract award) may become an area of greater impact.

. **PROCESS SAVINGS-** The technical capabilities of the vendor and their ability to work with the shipyard can be utilized to find ways to decrease costs without impacting quality or to improve quality without increasing costs. This may be the result of a new product or new use for an existing product which wiIl result in savings. Many times. the shipyard can take these concepts and implement a value engineering change will in crease the return to the shipyard. 'Ihese are especialy viable for shipyards invoIved with Navy Contracts.

• **PAYMENT TERMS -** THE shipyard can often negotiate favorable payment terms which can save as much as 3% for prompt payment of invoices. with the coatings Industry, where the competition is keen, this can have a significant impact on the cost of coatings to the shipyard. Other favorable situations with respect to payment of invoice can result for consignment situations, where the shipyard doesnot pay for the coatings until after they have used the coatings. and from other creative means of negotiating delivery of material and payment of invoices.

• **SOCIAL/COMMUNITY** - The coatings industry can be a source of a wide range of practices which can affect the community and environment in both positive and negative ways. Where these practices either support the philosophies of the shipyard or are contrary to those philosophies, the shipyard may elect to either do business or refram from doing business with a particular coating manufacturer.

• **INTUITIVE** APPRAISAL -This can be manifested in a number of ways. It may be a positive feeling about a new product or process which clearly represents the shipyard advancing their technology or a distinctly negative feeling In a similar situation. These feelings may lead a decision which is contrary to one that many of the factors indicate is the best interests of the yard In mostinstances, the intuitive appraisal is only used as a tie break for procure— ments In which two or more vendors have provided quotations which are essentially equal.

CONCLUSION

There are a wide range of factors which can influence the determination of value. Not all will be pertinent to a specific procurement and not all factors Will have the same importance. Therefore, a means of compiling the Information regarding the pertinent factors and their relative importance must be established. This should identify those factors which apply and assign each of those factors a weight based upon their relative importance. Each vendor's proposal will be evaluated and assigned a rating based upon the degree to which they meet the shipyard's requirements. Appendix A provides a sample of an evaluation matrx which can help to accomplish this task.

Some of the factors which apply to the pro-curement of coatings may represent a black and white situation in which a coating either meets the requirement or does not. For critical factors, such as safety and environmental issues, not meeting the shipyard requirement will disqualify a coating from consideration. These factors, along with basic issues such asresponsiveness to the RFQ and compliance with the specification, can be used to perform an initial screening of quotations and simplify the evaluation process. These black and white factors would then not need to be included in the evaluation and rating process.

The process of determining which of the value factors must be considered and establishing the relative importance of the pertinent factors should be conducted with input from all groups and departmets associated with the handling, storage, use and disposal of coatings and their wastes. This represents a continuation of the communication channels which were established to support the coating procurement process. Each group should have the opportunity to present their views and opinions regarding the evaluation of factors and their relative importance. A consensus of these opinions must be reached and used as the baseline for evaluating vendor proposals and quotations.

Similarly, each group or department should be solicited for their input regarding the rating given to the quotations with respect to their area of involvement. In some cases, groups will have input into a more than one area or value factor. Where this occurs, a consensus should be reached regarding the rating given to each vendor's quotation for that value factor. At this point, the purchasing agent will have all of the information necessary to execute the buy which provides the shipyard with the greatest coating value.

It is the responsibility of the purchasing group to establish and coordinate this effort. They must:

- maintain the lines of communication which are the basis for the entire process
- consider all input and create a procurement network in which all parties are represented and all concerns considered and addressed
- execute a procurement which satisfies the requirements of all shipyard departments and groups impacted by the coating process

The effect of accomplishing these tasks can be far reaching. Addressing as many issues as possible ahead of time will allow the shipyard to make the best decisions regarding each of the issues relating to coatings. It will also eliminate the need to respond to these issues when production may be impacted or when the avenues through which the issues maybe resolved are Iimited by a poor choicc made previously. When this process IS succesful, Purchasing, the Paint Department and all other groups which have contributed to the process will have delivered to the shipyard the required coatings with the greatest overall value, improved the quality of the product delivered, and improved the efficiency of the shipyard in providing the finished products.

APPENDIX A: EVALUATION MATRIX

Two examples of an evaluation matrix follow: one blank and one that is filled out with a theoretical example.

The blank example shows you might set up an initial evaluation matrix prior to the actual procurement. The value factors flow down in the first column and the possible vendors run across the top. The second column is for weighting the various factors as to importance. The weighting column total should add up to 100, with each factor's weighting usually ranging between 5 and 50 at the most. Each vendor is assigned a rating from 1-6, 6 being the best, for each of the factors. Then each rating is multiplied times the weighting and a score is calculated for each vendor by factor and in total. The higher the total score, the better the vendor performance on the evaluation matrix.

The second example is filled In with theoretical ratings for three vendors. Note that certain factors have been given a zero-these were not considered critical to this procurement and therefore have no value in the matrix (However, the Environment factor might strongly influence the buy if a particular vendor did not meet minimum environmental standards includedin the specifications.) On any given buy, you might well include addittonal facturs that are important to that particular procurement.

In this case, Vendor B had a substantially higher score of 480, based mainly on delivery, quality, and support services. Unless there were unusual circumstances surrounding their quote, they should receive the order. If two or more vendors have very close scores, that provides the opportunity Iook more closely at some of the factors to try and clarify difference or allows you to proceed with either.

Keep in mind that certain issues such as clearly meeting specs, financial stability, or environmental compliance can disqualify a vendor from even being actively considered in an evaluation matrix. For example, there would likely be no pointin evaluating a vendor that was just about to go bankrupt.

The evaluation matrix is a great tool for individuals and groups to rate vendor quotes and/ or proposals. It's also useful to evaluate most any situation that has many factors or issues. The concept is simple to use, but produces powerful results.

Appendix A: Evaluation Matrix Example

FACTORS	WEIGHTING (Total 100)	VENDOR A RATING (1-6)	VENDOR A SCORE (WEIGHTING X RATING)	VENDOR B RATING (1-6)	VENDOR B SCORE (WEIGHTING X RATING)	VENDOR C RATING (1-6)	VENDOR C SCORE (WEIGHTING X RATING)
Price							
Delivery							
Quality							
Support Services							
Warehousing							
Environment							
Safety							
Vendor Financials							
Personnel							
Guarantee							
Regulatory							
Process Issues							
Payment Terms							
Community							
TOTAL							

Appendix A: Evaluation Matrix Example Filled Out

FACTORS	WEIGHTING (Total 100)	VENDOR A RATING (1-6)	VENDOR A SCORE (WEIGHTING X RATING)	VENDOR B RATING (1-6)	VENDOR B SCORE (WEIGHTING X RATING)	VENDOR C RATING (1-6)	VENDOR C SCORE (WEIGHTING X RATING)
Price	20	5	100	4	80	3	60
Delivery	15	4	60	6	90	4	60
Quality	15	6	90	5	75	4	60
Support Services	10	2	20	5	50	3	30
Warehousing	10	5	50	4	40	6	60
Environment	0						
Safety	5	4	20	6	30	5	25
Vendor Financials	5	6	30	4	20	4	20
Personnel	5	3	15	5	25	6	30
Guarantee	5	2	10	6	30	5	25
Regulatory	0						
Process Issues	5	6	30	4	20	4	20
Payment Terms	5	4	20	4	20	4	20
TOTAL	**100**		**445**		**480**		**410**

APPENDIX B: TOTAL QUALITY MANAGEMENT

Appendix

TOTAL QUALITY MANAGEMENT

Total Quality Management (TQM) has become a way of business life pursued at many large and progressive companies, both in the U.S. and worldwide. It consists of an approach to people and process management that facilitates productive communication, employee empowerment, and business processes that are efficient. Traditional interdepartmental rivalries and their inherent inefficiencies are reduced and cross-functional cooperation becomes the standard approach. Changes of this magnitude take years to achieve, but the payoff in improved productivity and financial success is well worth the effort.

EMPLOYEE EMPOWERMENT

Employees closest to the work represent a tremendous resource that is sometimes overlooked. TQM creates an environment that taps this resource in an effective and productivemanner. Work groups (sometimes caIledQATS) come to gether to solve problems, redesign the workflow, or create solutions to a wide range of business problems. Management has ultimate control of these groups, but often can delegate significant decision-making to lower levels in the organization.

PROCESS IMPROVEMENT

All businesses consist of work processes that are linked together in a progressively complex and cross-functional manner that ultimately deliver the product or service to the external customer. While a focus on the external customer has been common for some time, the unique concept of TQM is the internal customer. Each business process hands off apiece of work to an internal customer, either in their own department or to another area as they add their particular value to the work.

Traditionally, internal customers were frequently at odds with one another over quality and process issues. TQM advocates that each person and department within a company treat their internal customers as if they were ther partner and the most important reason for their thdrbusiness existence. This eliminates the Competition and sets up an environment that produces cooperation and effciency. Internal customers work together to define the most productive business processes and also define what performance so that everyone knows what's expected. Over time,duplication of effort, inefficiency counterproductive competi-tion, and rework is eliminated.

PREVENTION

if an environments created and maintained that empowers employees and pushes down responsibility to the lowest possibIe level, and business processes are based on internal customer principles. traditional rework and repair costs are greatly reduced. Proactive effort and prevention becomes the focus of the organization. This results in incredible productivity and savings to the company. Just think how much labor and product costs would be saved if all coatings on a given ship were applied with little or no rework This would entail some up front labor costs to work out the process and needs, but thepaycdfatthe end is usually tremendous.

PURCHASING

Purchasing has a unique opportunity to promote the kind of cross-functional communication that is necessary in an existing or emerging TQM company. In each procurement they can organize the proper communications and information in advance of the procurement to assure that the material and the process it's used in is well-planned and considers Input from all appropriate areas. This key opportunity to foster a TQM work process makes Purchasing an important part of demonstrating and leading the way for Total Quality Management in their company.

Additional **copies of this report can be obtained from:**

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